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Energy poverty and gender in England: A spatial perspective

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ABSTRACT

A growing research agenda has sought to understand the substantial inequalities that exist in domestic energy provision. One way in which these inequalities are shaped is through socio-spatially contingent gender relations, an area underexplored with regards to energy poverty. This paper aims to uncover the spatialities of gender and energy poverty. It argues that established energy vulnerability frameworks can challenge the assumption that gender inequality is synonymous with energy poverty, but to do so these framings must move beyond a focus upon the household to recognise the vulnerability of individuals. Gendered vulnerabilities likely to enhance energy poverty are delineated for a case study of England, underpinned by socio-spatial analyses of gender-sensitive indicators. Five dimensions of gendered, socio-spatial energy vulnerability are evidenced in this context: exclusion from the economy; time-consuming and unpaid reproductive, caring or domestic roles; exposure to physiological and mental health impacts; a lack of social protection during a life course; and coping and helping others to cope. The findings demonstrate that whilst it is possible to draw initial conclusions about the spatialities of gendered energy vulnerability associated with health and economic activity, this is more complex concerning gendered aspects of energy vulnerability related to infrastructure that tend to be measured at the scale of the household, or those aspects of vulnerability that are relatively private or personal.

1. Introduction

Across the so-called Global North a renewed focus upon the relationship between gender and poverty in the wake of the Global Financial Crisis and subsequent period of austerity (Rubery, 2015) has highlighted the disproportionate impact that cuts to public spending are having upon women, particularly those in marginalised groups (A Fairer Deal for Women, 2016), disrupting and in places reversing progress towards gender equality (Perrons, 2015). Concern about the distributional and recognition injustices associated with neo-liberalism and austerity have also prompted a drive to understand the socio-spatial vulnerabilities that enhance energy poverty (also referred to as fuel poverty in this context) (Walker and Day 2012). Inspired by the concept of *relative* poverty (Townsend, 1979), Buzar defines the energy poor as those living without access to the socially and materially necessary domestic energy services (for example, heating, lighting or cooking) that allow their meaningful participation in the society in which they live. Across the Global North, including the case study of England, the neo-liberalisation of two key institutional and infrastructural arrangements, energy markets and housing markets, and deepening of relative inequality, has played a substantial role in the manifestation of new energy poverty challenges (Petrova, 2017, 2018; Robinson et al., 2019; Tirado and Jimenez Meneses, 2016). A growing body of research has begun to explore in greater depth the socio-spatial vulnerabilities that increase the likelihood of experiencing energy poverty in this context (Middlemiss and Gillard, 2015; Reames, 2016; Mashhoodi et al., 2019; Robinson et al., 2019). However, often missing from the conversation is gender.

Drawing upon decades of feminist scholarship, here gender is understood as the social, economic and political constructions of 'femininity' and 'masculinity', a fundamental axis of social power that shapes social relations in an unequal way. Central to such scholarship is the understanding that gender is not, however, a discrete category. Rather it is mutually constructed with other forms of social difference including class, ethnicity, race, able-ness, sexuality and age (Benería and Roldan, 1987; Crenshaw, 1991). For McDowell (1999) these interconnections with other axes of social power and oppression mean that gender relations are constituted in varied and uneven ways over space and time. McDowell highlights how 'the advantages and disadvantages conferred by the social constructions of masculinity vary across space and time, as they intersect with class relations, labour market changes and the geographically specific relations of place' (2016: 2093). Likewise, Massey, in conceptualising the relationship between gender and space, argues that 'what it means to be masculine in the Fens is not the same as in Lancashire' (1994:179). Geographical variations in gender relations then, it is argued, are integral to the construction and

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reproduction of geography either through their contribution towards uneven development or regional and local variations (Massey, 1994; McDowell, 2007).

By contrast, existing development-focused, energy poverty literatures have tended to promote binary, disempowering and victimising gender discourses (Listo, 2018) whilst in the context of the Global North energy is often regarded as gender-neutral (Clancy and Roehr, 2003). There is subsequently a need for research that scrutinises the uneven, gendered geographies of energy poverty (Petrova and Simcock, Under review). Subsequently, this paper aims to uncover the spatialities of gender and energy poverty. Firstly, the paper outlines how existing energy vulnerability framings can be adapted to explore gender inequality. A series of gender-sensitive, demographic indicators that are indicative of enhanced vulnerability to energy poverty are then derived at a neighbourhood-scale for a case study of England. The analysis is what McCall (2005) terms inter-categorical, *necessarily* adopting existing analytical categories (including women and men) to highlight processes of marginalisation. A socio-spatial analysis of these indicators reveals some of the diverse and contradictory geographies of gendered vulnerability to energy poverty in this context. The analysis also allows for reflection on the challenges of representing gendered energy vulnerabilities at the neighbourhood scale.

2. Gender inequality and (energy) poverty

An understanding of gender as a fundamental axis of social power that, through interconnections with other axes of difference, shapes social relations in an unequal way (Crenshaw, 1991; McDowell, 1999) has not always been central to conversations about gender and poverty. Much of the debate about the relationship between gender and poverty has focused upon the Global South, alongside issues of gender inequality in access to education, healthcare, decent work and representation in political decision-making processes. During the 1980′s, the '*feminisation of poverty*' agenda (Pearce, 1978) sought to highlight the disproportionate number of women experiencing poverty. Whilst elevating gender in international poverty discourses (Chant, 2008), the conceptualisation perceived gender issues as a variation of poverty, and poverty alleviation as the primary means to improve the position of women (Jackson, 1996; Chant, 2004, 2006, 2008). The agenda ignored how gender can be distinct from and contradict poverty and how poverty is a negative outcome of unequal social relations that are shaped by gender, rather than *vice versa*. Multi-dimensional aspects of gender disadvantage such as housing, basic services (including energy) and rights were also overlooked (Sen, 1999; Razavi, 1999; Chant, 2004). Constructing women as a somewhat homogenous group, a 'lack of breakdown according to other axes of difference prevented any dedicated investigation of which particular groups of women… might be especially prone to privation' (Chant, 2006: 204).

These shortcomings have been challenged by intersectional feminism that contests the idea that women experience oppression and disadvantage in a similar way (Benería and Roldan, 1987; Crenshaw, 1991; Davis, 2008; McCall, 2005; Shields, 2008). Rather gender inequality varies in its configuration and intensity due to interconnections with other axes of social difference and oppression including class, race, ethnicity, able-ness, sexuality and age. Such interconnections mean that gender relations are constituted in varied and uneven ways over space and time and are integral to the construction and reproduction of geography (McDowell, 1999, 2016; Massey, 1994). For Kabeer (2011), the pervasive nature of gender inequality means that it cuts across spatial inequalities in addition to social inequalities, taking different forms in different societies. Thus 'women's poverty is experienced in different ways, at different times, in different "spaces"' (Bradshaw, 2002:12). These primarily development-focused debates have also translated into a more nuanced understanding of the socio-spatial variability of relations between gender inequality and poverty in the Global North (e.g. Barnard and Turner, 2011).

By contrast, research about the relationship between gender and energy poverty in the Global South (reviewed in Listo, 2018) has been critiqued for a tendency to endorse a "feminization of energy deprivation" (Petrova and Simcock, Under review: 1) and promoting binary, disempowering and victimising gender discourses (Listo, 2018). Listo (2018) documents how the issue is often depoliticised by a failure to recognise how a lack of energy services is just one way that gender inequalities are materially expressed, and that gender inequalities are in fact generated by unequal power relations between men and women, and other groups. Whilst some attention has been paid to the intersection of gender with other axes of social difference including for example race (Annecke, 2003) and class (Standal and Winther, 2016), Listo (2018) argues that women are often co-opted and instrumentalised to justify energy-related interventions at the expense of gender equality. For Standal and Winther (2016), the assumption that gender inequality is resolvable with these interventions conceals the power relations that cause gender inequalities to manifest and as such these interventions can in fact reinforce patriarchal structures.

A handful of studies have offered a 'Northern perspective' on this debate (Clancy and Roehr, 2003; Clancy et al., 2017, Petrova and Simcock, In Review). Instead of constructing women as victims or "feminizing" energy poverty, Clancy and Roehr contended that "energy, in a Northern context, is seen as gender-neutral; women and men are regarded as equal in their uses of and views about energy" (2003: 44). They argue that this is a common misconception, citing evidence of a distinct gender dimension in the way in which the lives of women and men are impacted by energy use in the Global North, including the case study of England. From a political economy perspective it is widely recognised that despite the increasing role of women in paid employment, structural inequalities including those in the labour market and welfare system continue to perpetuate gender inequalities. Meanwhile, specific responsibilities associated with socially-constructed gender roles mean that household tasks and childcare remain principally the responsibility of women. Whilst identifying temporal and spatial variation in these responsibilities, Clancy and Roehr (2003) emphasise that it is not unreasonable to assume that similar divisions are likely to exist in relation to domestic energy use. Furthermore, insufficient attention is paid to the multiplicity of gender identities that result from the intersection of gender with other axes of social difference, and the relationship between these multiple gender identities and household energy use. Such misconceptions have also translated into energy-related policy-making in this context. Clancy et al. (2017) emphasise the need for an improved understanding of gender inequality in relation to energy in the first comprehensive review in the context of the European Union (EU). The review stresses the need for gender to be accounted for in the definition and measurement of energy poverty, including designing indicators that are sensitive to gender.

A recent publication by Petrova and Simcock has sought to move beyond some of the disempowering narratives that have featured prominently in research to date in this context, drawing upon qualitative household-scale research in several European cities to explore the "overlooked politics of mundane energy use-related practices in both constituting, and being constituted of, gender…inequities" (Under review: 1). They illustrate ways in which experiences of energy poverty in the home are differentiated along gender lines, emphasising the agency of household members who are actively involved in household decision-making. However, recognition of gender as a system of disadvantage also needs to extend beyond a focus upon the home to scrutinise the uneven and gendered geographies of energy poverty at different scales. In response, the analysis that follows analyses the spatialities of gender and energy poverty at a neighbourhood-scale through the first quantitative, spatial assessment of gendered energy vulnerability to date.

3. Gendered socio-spatial vulnerability to energy poverty

To better understand the relationship between gender inequality and energy, in particular the spatialities of this relationship, the concept of vulnerability can be mobilised. Vulnerability explains the differential losses between varied societal groups and places arising from a stressor, identifying the characteristics of those most susceptible to harm and the likelihood of them experiencing negative outcomes (Adger, 2006; Cutter et al., 2003), and providing a means of mitigating against threats to people's integrity (Middlemiss and Gillard, 2015). To date, vulnerability framings have been used to highlight several dimensions that increase the likelihood of a household experiencing energy poverty: unaffordability of energy, energy inefficiency, inflexibility in the built environment including tenure arrangements, and energy-related needs and practices that increase energy use (Bouzarovski and Petrova, 2015; Middlemiss and Gillard, 2015). Meanwhile, the complimentary precarity framework (Petrova, 2017), explores wider institutional factors that contribute. Such framings highlight how vulnerability manifests in households with a range of socio-economic, demographic and socio-technical characteristics. Attention is also drawn to the uneven spatial distribution of energy-related vulnerability (Bouzarovski and Thomson, 2018; Mashhoodi et al., 2019; Scarpellini et al., 2019; Reames, 2016) and its temporal variability as household circumstances change over time (Middlemiss and Gillard, 2015).

Within energy vulnerability research there have been comparatively fewer conversations about gender. This can be partially explained by a reluctance to associate gender inequality with a concept that, if applied without careful thought, can reinforce detrimental discourses that have characterised women as vulnerable, submissive and repressed, and fail to reflect individual agency (Listo, 2018). Day and Hitchings (2011) exploring energy poverty amongst older age groups highlight how labelling groups as vulnerable can be counterproductive to relieving marginalisation. However, in articulating feminist intersectionality, Crenshaw (1991) contradicts the view that identity categories are negative frameworks that marginalise those who are different and should be dismantled, arguing that delineation of difference can be a form of social power and that intra-group differences cannot be ignored. Meanwhile, Walker and Day (2012) recognise the importance of making visible social vulnerabilities to address associated injustices, in relation to both distributional concerns about access to resources and recognition concerns regarding power and voice.

In seeking to understand the ways in which the socio-spatial inequalities that give rise to energy poverty are gendered, a vulnerability framing has two key strengths. Firstly, it contradicts the common assumption that gender inequality is synonymous with poverty (Jackson, 1996, Listo, 2018). By focusing upon the likelihood of falling into the condition of energy poverty, it is not assumed that gender inequality is just one aspect of deprivation. Rather, it is possible to demonstrate how gender inequality, through its intersection with other axes of social differentiation, results in a greater exposure of marginalised women to the negative impacts of energy poverty. Secondly, it provides a powerful means of recognising socio-spatial differentiations in the degree of susceptibility to energy poverty, helping to conceptualise the intersections and the mutually reinforcing relations between gender and other axes of social (*socio*) difference, including class, ethnicity, race, disability, sexuality and age, and how these inequalities manifest in certain places (*-spatial*) with varying intensity.

Outlining a global framing of vulnerability to energy poverty, Bouzarovski and Petrova note the importance of 'the individual, household and community-level determinants of energy dynamics in the residential environment' (2015: 35). Yet, to date Tirado recognises 'a fundamental assumption in the energy poverty and domestic energy use literature, that takes households – not individuals – as the key micro unit" (2017: 1026). A focus on the household is justifiable given the importance of infrastructure in domestic energy-related inequalities. However, it also wrongly assumes an equitable distribution of resources amongst household members, making research somewhat 'gender-blind' (Millar and Glendinning, 1989). Gender, rather than being included as a variable within existing analyses, requires a different analytical framework (Millar and Glendinning 1989). In response, an individual deprivation measure (IDM) has been proposed that illuminates rather than obscure gender inequality (Bessell, 2015). However, this has rarely been absorbed by mainstream poverty metrics. Subsequently, to succeed in understanding gender inequality, energy vulnerability framings must move beyond a concern with the household to the individual. With this framing in mind, I turn my attention to applying the framework to derive a selection of gender-sensitive indicators of vulnerability to energy poverty.

4. Deriving gender-sensitive indicators of vulnerability to energy poverty

Building upon the recommendations of Clancy et al. (2017), gender-sensitive indicators of vulnerability to energy poverty are analysed for neighbourhoods across the case study of England. A recent report on intersectional inequalities by the Women's Budget Group recognised how "structural inequalities [in the UK] between women and men continue to be widespread; women earn less, own less, have more responsibility for unpaid work, remain underrepresented in decision-making" (2018: 9), a state that is comparable to many geographical contexts across the Global North. Concurring with Clancy and Roehr (2003) it can therefore be reasonably assumed that more women than men are likely to be living in energy poverty. Furthermore, this form of gendered inequality will vary in its configuration and intensity owing to interconnections with other axes of social difference. The gender-sensitive indicators in the analysis that follows are therefore selected to provide understanding of the relationship between gender inequality and energy in this context, and allow for relative comparison of the socio-spatial distribution of gendered energy vulnerabilities.

In such an analysis, the way in which administrative datasets are collated necessitates relying upon the binary of women and men as a proxy for gender, in addition to other fixed categories of social difference including disability, age and ethnicity (ONS, 2011a). These categorisations can obscure a variety of identities and imply that predefined social groups can be incrementally added to one another to understand the depth of a person's marginalisation. This falsely dichotomises and concretises what are inherently entangled forms of oppression (Butler, 1990, Valentine, 2007) (see Section 7 for further discussion of limitations). However, whilst imperfect, the categorisations have a useful role in making visible the positions and outlooks of women and supporting research that leads to social change (DeVault, 1996, McLafferty, 1995, Sprague and Zimmerman, 1993). The analysis is therefore what McCall terms an *intercategorical* approach that "provisionally adopts analytical categories to document relationships of inequality amongst social groups and changing configurations of inequality along multiple conflicting dimensions" (2005: 1773). The categories of women and men provide an 'anchor point' from which to explore their relationality with other axes of social difference (Glenn and Tam, 2004).

The analysis combines two methodological approaches. The first approach asks - *which aspects of energy vulnerability are likely to be gendered?* Unlike many established sub-regional deprivation indexes that represent gender using the percentage of females and males within each geographical unit (Cutter et al., 2003), the analysis does not begin with the assumption that women are more vulnerable to energy poverty. Instead it investigates whether well-understood aspects of energy vulnerability are gendered. From an existing typology of vulnerability indicators underpinned by an extensive review of qualitative research (Robinson et al., 2019), representative indicator datasets are identified from the 2011 Census (ONS 2011a). The datasets must be available at the Lower Super Output Area (LSOA) neighbourhood scale (representing on average 1500 individuals), have the individual as the primary unit of analysis within the neighbourhood, and be

Table 1
Local Moran's I Clusters and Outliers.

Cluster or Outlier	Description	Local Moran's I Z-score
High-High (HH) Cluster	'Hot spot' of high values due to the local association of LSOA in which a high percentage of individuals are vulnerable	> 0
High-Low (HL) Outlier	A high value surrounded by predominantly low values	< 0
Low High (LH) Outlier	A low value surrounded by predominantly high values	< 0
Low-Low (LL) Cluster	'Cold spot' of low values due to the local association of LSOA in which a low percentage of individuals are vulnerable	> 0

disaggregated by sex (ONS 2011b). A One-Way ANOVA test determines whether there is a statistically significant, gendered aspect to each indicator, i.e. whether females are over-represented. Due to dataset restrictions, cross-clarification of the gender-sensitive indicators to reveal interconnections with other forms of social difference is not possible, restricting the analysis to an additive linear model (McCall, 2005).

To overcome these limitations, the second stage of the analysis asks – *how is gendered energy vulnerability spatially distributed?* in addition to - *how do gendered aspects of vulnerability spatially intersect?* A Local Moran's I Cluster and Outlier analysis (Anselin, 1995) identifies local patterns of association, including 'hot' spots (High-High Clusters) and 'cold' spots (Low-Low Clusters) of vulnerability according to each gender-sensitive indicator, providing information about its relative distribution between neighbourhoods across England (Table 1). During the analysis each LSOA is represented by a population weighted centroid, a single point reflecting the concentration of population within the small area (ONS, 2011b) (Waller and Gotway, 2004). A spatial weights matrix conceptualises the spatial relationship for the Cluster and Outlier analysis using the eight nearest neighbours to reflect how urban areas tend to be more spatially concentrated. These Clusters and Outliers are statistically significant for a 95% confidence level. H-H Clusters from the Local Moran's I analyses are overlaid to consider spatial interconnections amongst the indicators, and subsequently the role of other forms of social difference in gender differentiations in energy vulnerability. The gender-sensitive indicators provide insight into the variety and geography of gendered vulnerabilities that enhance the likelihood of energy poverty, inviting reflection on why these geographies arise.

5. A typology of gender-sensitive indicators of vulnerability to energy poverty

From a typology of energy vulnerability designed by Robinson et al. (2019), 13 indicator datasets are obtained that fulfil the selection criteria (Table 2). Each indicator is analysed to understand whether women are disproportionately represented relative to their male counterparts (Table 3). Nine gender-sensitive indicators of vulnerability to energy poverty are retained: older age, disability and illness, lone parent, part-time employment, looking after family or home, provision of unpaid care, proficiency in English, fulltime student and pensionable age and living alone. It is worth noting that, although these indicators highlight characteristics associated with a greater susceptibility to energy poverty, it should not be assumed that all individuals represented will be energy poor. The typology of indicators does not consider how vulnerability amongst women might also be alleviated by certain factors, or how the intensity of vulnerability varies between indicators. In the section that follows, Cluster and Outlier analyses of the nine gender-sensitive indicators (Table 4, Fig. 1) are situated within a review of energy poverty literatures to explore the spatialities of gender and energy poverty.

6. The gendered geographies of vulnerability to energy poverty

Five dimensions of gendered, socio-spatial vulnerability to energy poverty are outlined: exclusion from the economy; time-consuming and unpaid reproductive, caring or domestic roles; susceptibility to negative physiological and mental health impacts; lack of social protection during a life course; and coping and helping others to cope. The nine gender-sensitive indicators identified interrelate with these five dimensions (Fig. 2). Whilst the focus of the analysis is upon England, these dimensions are of relevance in understanding gendered aspects of vulnerability to energy poverty in other national contexts, in Europe and beyond. Although, as contended by Williams (2010) gender should be treated as contextually and culturally specific and the direct application of the dimensions is discouraged.

Table 2
Vulnerability indicators and datasets that can be broken down by sex.

Vulnerability indicator[1]	Y/N[2]	New indicator dataset (by sex) ONS (2011a)
Older old	Y	Over 75 years
Young children	N	–
Disability and limiting illness	Y	Day-to-day activity is limited a lot
Lone parent	Y	Lone parent with dependent children
Part-time occupation	Y	Part-time employment
Retired	Y	Full time students
Looking after family or home	Y	Looking after family or home
Provision of unpaid care	Y	Providing unpaid care (20+ hours)
Unemployment	Y	Unemployed
Elementary occupation	Y	Elementary occupation
Proficiency in English	Y	Can't speak English well or can't speak English
Ethnicity	Y	Persons whose ethnic group is non-British
Full time student	Y	Fulltime students
Living alone	Y	Aged over 65 years and living alone
Under-occupancy	N	–
Shared property (HMO)	N	–
Large household size	N	–
Private renting	N	–
No central heating	N	–
No access to gas network	N	–
Inefficient property	N	–
Low outdoor temperature	N	–

[1] Extracted from Robinson et al. (2019) and Robinson et al. (2018).
[2] Is a sub-regional indicator dataset available using unit of individual, and broken down by sex? Yes (Y) or no (N).

6.1. Time-consuming and unpaid reproductive, caring or domestic roles

Despite the increasing role of women in paid employment, definitions of waged labour reflect a "masculine" ideal of work that is highly problematic, devaluing the labour associated with domestic and caring roles that are often the responsibility of women due to socially-constructed gender norms. Such reproductive roles tend to be under accounted for in the practices and policies of institutions (McDowell, 1999) with implications for vulnerability to energy poverty.

Responsibility of care for dependent children or those with a disability, illness or age-related needs falls disproportionately to women (Pickard, 2015), as demonstrated by the indicators of unpaid care, lone parents and looking after the family or home. Of those people who provide 20+ hours of unpaid care a week in England, approximately a third more are women. Meanwhile, 89% of lone parent families with dependent children are headed by a woman (ONS, 2011a). This aspect of vulnerability is particularly acute for BME women are more likely to live in households with dependent children. Recent statistics from the

Table 3
Summary statistics and One-Way ANOVA for vulnerability indicators, broken down by sex.

Indicator ONS (2011a)	Females (% values for LSOA)				Males (% values for LSOA)				One-Way ANOVA			Gender-sensitive indicators for further analysis (unit)
	Mean	Min	Max	SD	Mean	Min	Max	SD	Mean sq.	F	Sig.	
Older old	9.17	0.00	47.98	4.83	6.54	0.00	36.55	3.45	114354.53	6438.714	0.00*	Aged over 75 years old (% females)
Disability or limiting illness	18.40	2.70	59.03	5.48	16.18	1.80	51.5	5.17	80767.14	2845.31	0.00*	Day-to-day activities limited a lot (% females)
Lone parent	7.23	34.06	0.00	4.35	0.80	0.00	12.29	0.58	678886.89	70479.07	0.00*	Lone parent (% females, 16–74 yrs)
Part-time employment	21.50	0.91	37.83	4.35	6.10	0.55	28.11	2.07	3893883.09	250757.18	0.00*	Part-time employment (% females 16–74 yrs)
Looking after home	7.87	0.09	37.78	3.85	0.83	0.00	5.97	0.66	813497.55	106461.52	0.00*	Looking after family or home (% females 16–74 yrs)
Provision of unpaid care	4.42	0.00	12.23	1.54	3.19	0.00	11.11	1.30	25073.20	12331.80	0.00*	Provision of unpaid care, (% females 16–74 yrs)
Unemployment	3.51	0.00	15.80	2.00	5.30	0.16	26.44	3.12	52864.05	7710.66	0.00*	*Statistically significant for males*
Elementary occupation	11.18	0.25	45.71	5.45	11.88	0.45	46.41	5.77	7942.27	252.27	0.00*	*Statistically significant for males*
Proficiency in English	1.85	0.00	37.95	3.35	1.28	0.00	23.44	2.08	5359.57	690.05	0.00*	Proficiency in English, (% females 16 yrs +)
Ethnicity	19.42	0.32	99.23	22.41	19.10	0.00	99.73	22.12	1742.36	3.52	0.61	*No statistically significant difference*
Student	8.73	0.86	91.02	7.47	8.46	1.17	93.91	7.32	1138.45	20.82	0.00*	Fulltime students (% females 16–74 yrs)
Pensionable age/living alone	7.22	0.00	41.49	3.65	3.33	0.00	28.22	1.65	247821.13	30951.18	0.00*	Living alone and over 65 years old (% females)

Table 4
Local Moran's I for gender-sensitive vulnerability indicators.

Cluster or Outlier	LSOA (count)	Mean z-score (p value)[1]	Min. value (%)	Max. value (%)	Mean value (%)
Older old					
Not significant	25,955	0.23 (0.64)	0.13	33.93	9.23
HH Cluster	2803	5.90 (< 0.05)	10.94	47.98	18.12
HL Outlier	197	−2.83 (< 0.05)	12.14	34.69	17.81
LH Outlier	203	−2.88 (< 0.05)	0.17	7.88	4.12
LL Cluster	3686	3.47 (< 0.05)	0.00	6.43	3.23
Disability and illness					
Not significant	24,579	0.73 (0.61)	4.96	40.00	18.18
HH Cluster	4060	4.81(< 0.05)	20.49	47.49	27.06
HL Outlier	172	−3.0(< 0.05)	20.83	59.04	26.41
LH Outlier	182	−2.92(< 0.05)	4.95	15.92	11.65
LL Cluster	32,844	4.15(< 0.05)	1.49	15.91	10.68
Lone parent					
Not significant	26,854	0.33 (0.60)	0.20	30.81	6.42
HH Cluster	3855	6.54 (< 0.05)	8.53	34.06	15.23
HL Outlier	122	−2.72 (< 0.05)	10.77	24.02	15.03
LH Outlier	225	−2.78 (< 0.05)	0.26	5.62	3.31
LL Cluster	1788	2.67 (< 0.05)	0.00	4.59	2.24
Part-time employment					
Not significant	23,688	0.39 (0.64)	4.18	35.7	22.36
HH Cluster	3834	3.58 (< 0.05)	23.87	37.83	28.28
HL Outlier	18	−2.87 (< 0.05)	25.21	33.83	27.60
LH Outlier	37	−2.62 (< 0.05)	4.89	18.95	14.88
LL Cluster	5267	8.15 (< 0.05)	0.91	19.69	12/73
Looking after family or home					
Not significant	27,194	0.34 (0.65)	0.28	22.85	7.29
HH Cluster	3254	11.86 (< 0.05)	8.81	37.78	15.69
HL Outlier	75	−2.85 (< 0.05)	10.36	22.43	14.56
LH Outlier	103	−3.47 (< 0.05)	1.04	6.77	4.34
LL Cluster	2218	2.97 (< 0.05)	0.09	5.80	3.41
Provision of unpaid care					
Not significant	23,817	0.34 (0.61)	0.37	9.49	4.34
HH Cluster	4512	5.18 (< 0.05)	5.06	12.23	6.85
HL Outlier	110	−2.81(< 0.05)	5.29	8.68	6.50
LH Outlier	108	−2.73 (< 0.05)	0.79	3.61	2.79
LL Cluster	4297	4.18 (< 0.05)	0.69	6.43	1.48
Low proficiency in English					
Not significant	29,216	0.43 (0.66)	0.00	17.48	0.89
HH Cluster	3617	18.08 (< 0.05)	2.81	37.95	9.64
HL Outlier	0	0.00 (< 0.00)	0.00	0.00	0.00
LH Outlier	11	−2.69 (< 0.05)	0.00	0.70	0.20
LL Cluster	0	0.00 (< 0.05)	0.00	0.00	0.00
Fulltime student					
Not significant	30,673	0.35 (0.76)	1.17	59.26	7.33
HH Cluster	2134	23.78 (< 0.05)	10.56	93.91	28.55
HL Outlier	27	−3.10 (< 0.05)	19.60	58.99	33.60
LH Outlier	10	−2.80 (< 0.05)	3.44	6.58	5.63
LL Cluster	0	0.00	0.00	0.00	0.00
Pensionable age and living alone					
Not significant	26,753	0.19 (0.65)	0.1	32.79	7.12
HH Cluster	2415	5.57 (< 0.05)	8.04	36.02	14.06
HL Outlier	220	−3.07 (< 0.05)	9.17	41.5	14.48
LH Outlier	217	−2.79 (< 0.05)	0.28	5.75	3.28
LL Cluster	3239	3.54 (< 0.05)	0.00	5.24	2.63

[1] Significant for a 95% confidence level.

Women's Budget Group (2018) evidence how half of Bangladeshi, Pakistani or Black African households have at least one dependent children compared with approximately a quarter of White British households.

Such caring responsibilities leave women, especially those in lower income households, with less time for earning a living and more reliant upon precarious or part time employment that provides the flexibility to accommodate caring roles (Pickard, 2015; Kwan, 1999). These dynamics are likely to enhance vulnerability to energy poverty as lower incomes mean that energy bills and the need to invest in energy efficient infrastructures can become a substantial financial burden (Boardman, 1991; Brunner et al., 2012). In turn, energy vulnerability is

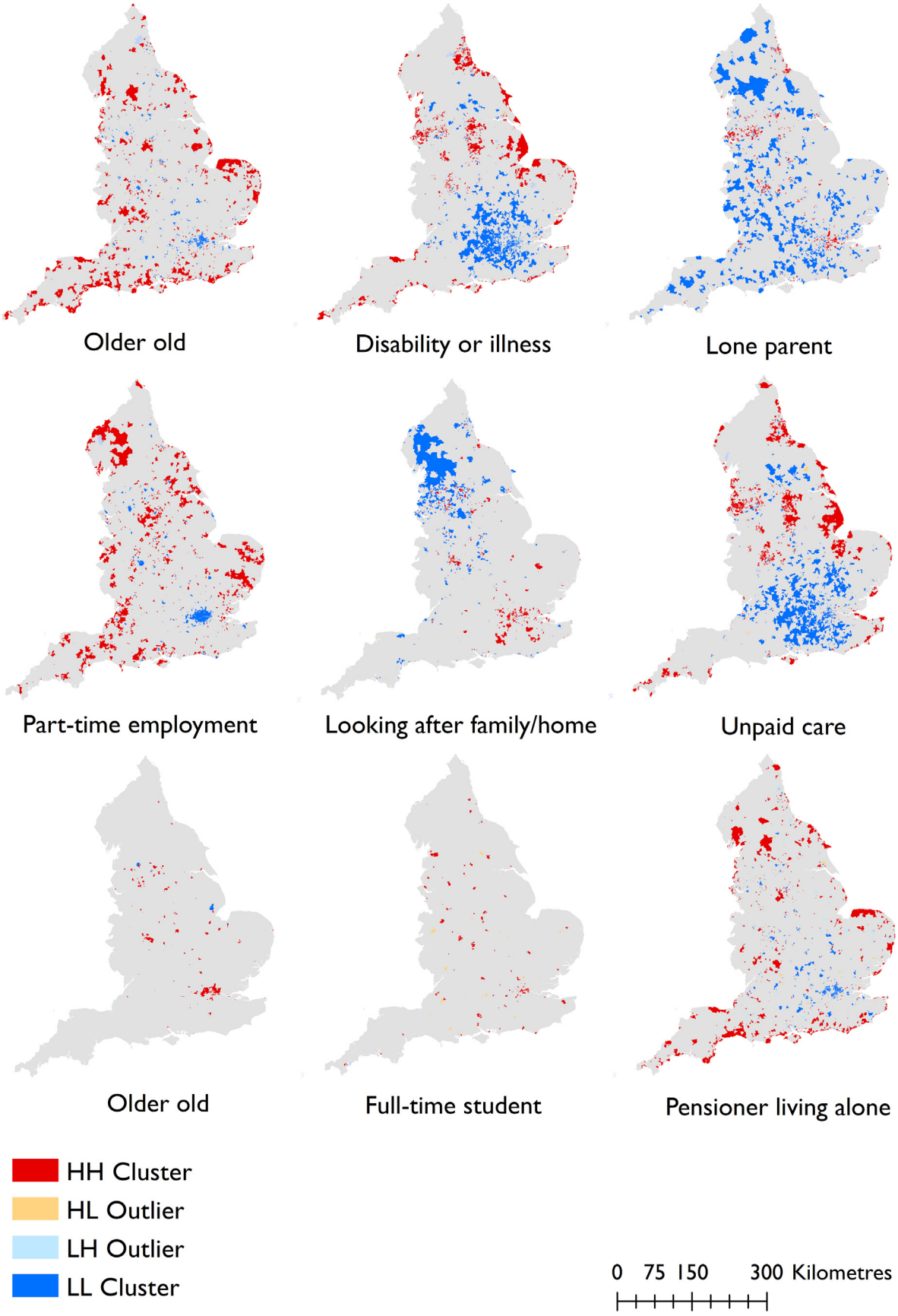

Fig. 1. Clusters and Outliers of gender-sensitive vulnerability indicators (ONS, 2011b).

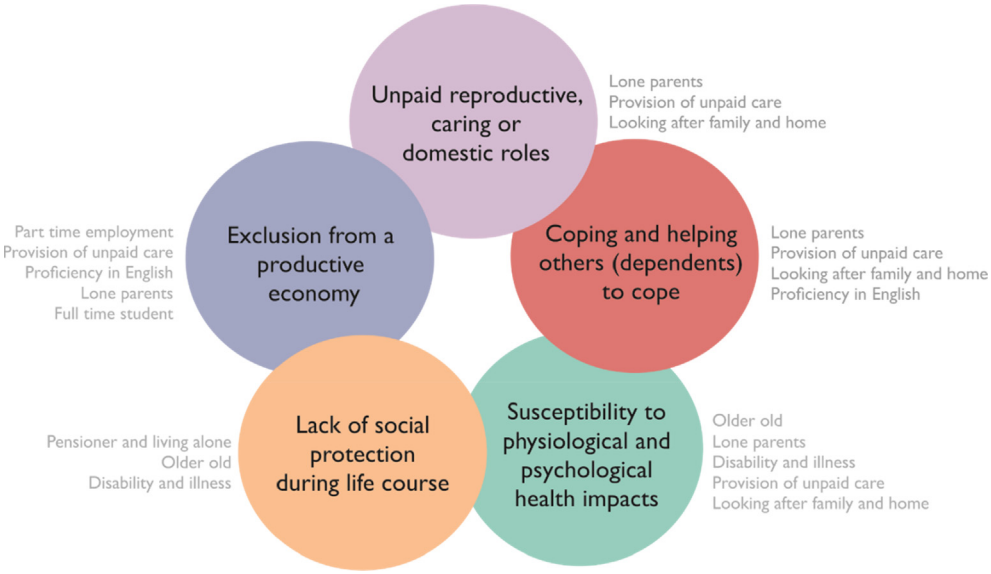

Fig. 2. Dimensions of gendered vulnerability to energy poverty and associated indicators.

greater restricting individual autonomy and the ability to make choices in everyday life about energy suppliers, types of fuel, energy-related infrastructures and energy services (Middlemiss and Gillard, 2015). Unpaid caring and domestic activities are also more strongly fixed to a specified time or place (Schwanen et al., 2008) with implications for exposure to energy poverty due to prolonged time spent in the home during the day (Chard and Walker, 2016; Healy and Clinch, 2004).

In the Cluster and Outlier analyses (Fig. 1), the indicator related to care has a distinct geographical distribution, with unpaid, female carers concentrating in post-industrial, urban conurbations in the north of England, and coastal communities. These areas experience relatively acute income deprivation (Fernández-Bilbao, 2011) and have been disproportionately impacted by welfare reform policies (Beatty and Fothergill, 2014). Such structural inequalities related to the economy and welfare provision mean that, despite a relatively high percentage of lone parents or members with a disability or illness, many households in these regions are less able to afford the provision of care or childcare, meaning that marginalised women are disproportionately vulnerable to energy poverty.

6.2. Exclusion from a 'productive' economy

Over recent decades a change in the aspirations and economic activities of women in the Global North has been evidenced, however, systemic discrimination and structural gendered inequalities continue to exist in the labour market (Rubery, 2015) enhancing vulnerability to energy poverty in a variety of ways.

Interlinked with caring responsibilities, marginalised women are disproportionately excluded from the so-called "productive" economy. Feminisation of the labour market has focused upon flexible labour, a flexibility that is designed to facilitate the gendered caring or domestic roles (Section 6.1). Although less likely than their male counterparts to be unemployed (Fig. 3), a high percentage of women are either in part-time employment or fulltime education (Fig. 3). A gender-specific "part-time penalty" is recognised in which women who change to part-time roles become trapped in low-paid, precarious employment (Manning and Petrongolo, 2008). Hochschild (2003) also evidences a 'time-bind' in which women have a double burden of paid work whilst assuming the bulk of caring responsibilities at home, a time-bind that is often intergenerational as grandparents increasingly assume caring responsibilities for children (Ward et al., 2007).

Low incomes as a result of this gender-specific form of economic exclusion mean that marginalised women may be less able to afford energy bills or to invest in new energy efficient infrastructures, drivers that are central to energy poverty (Boardman, 1991). This form of vulnerability is often most acute amongst lone parents who are disproportionately women (Gingerbread, 2013; Healy and Clinch, 2004). Lone parenting responsibilities makes engagement in full time employment and subsequently covering energy bills more difficult (Gingerbread, 2013). Economic exclusion also intersects with other axes of inequality, as evidenced by the indicator highlighting the disproportionate number of women without proficiency in English, and additionally the translation of vulnerability into older age owing to lower pension contributions (Section 6.3).

In addition to exclusion from labour markets, for every hour worked women are paid less on average than their male counterparts, with women in the EU earning over 16% less per hour worked, a gap that increases with age (European Commission, 2017). The pay gap also intersects with other forms of social difference, for example, in the UK disabled men experience a pay gap of 11% compared to non-disabled men, whilst for disabled and non-disabled women the gap in pay doubles to 22% (Papworth Trust, 2016). Wider research has also evidenced additional forms of discrimination and bias experienced by BME women in the labour market, including sexism and racism (Batnitzky and McDowell, 2011). The subsequent dependence of women upon male earners can further undermine financial flexibility, preventing them from engaging in energy-related decision-making and reducing the capacity to negotiate the relationship between affordability and energy services (Middlemiss and Gillard, 2015).

The geographies of indicators associated with economic exclusion are divergent, highlighting the multi-faceted nature of gendered energy vulnerability associated with labour (Fig. 1). As shown, economic exclusion due to the provision of unpaid care is spatially concentrated in large urban conurbations in England, especially post-industrialised, northern cities. In contrast, the part-time employment indicator highlights relative vulnerability in large swathes of rural areas, highlighting areas in which part-time work is likely to supplement retirement.

6.3. Exposure and susceptibility to the negative physiological and mental health impacts of being without sufficient energy services

Gender norms, as well as a person's sex, play a role in both their physiological but also psychological experience of health (Vlassoff, 2007). Women are overrepresented by indicators representing older

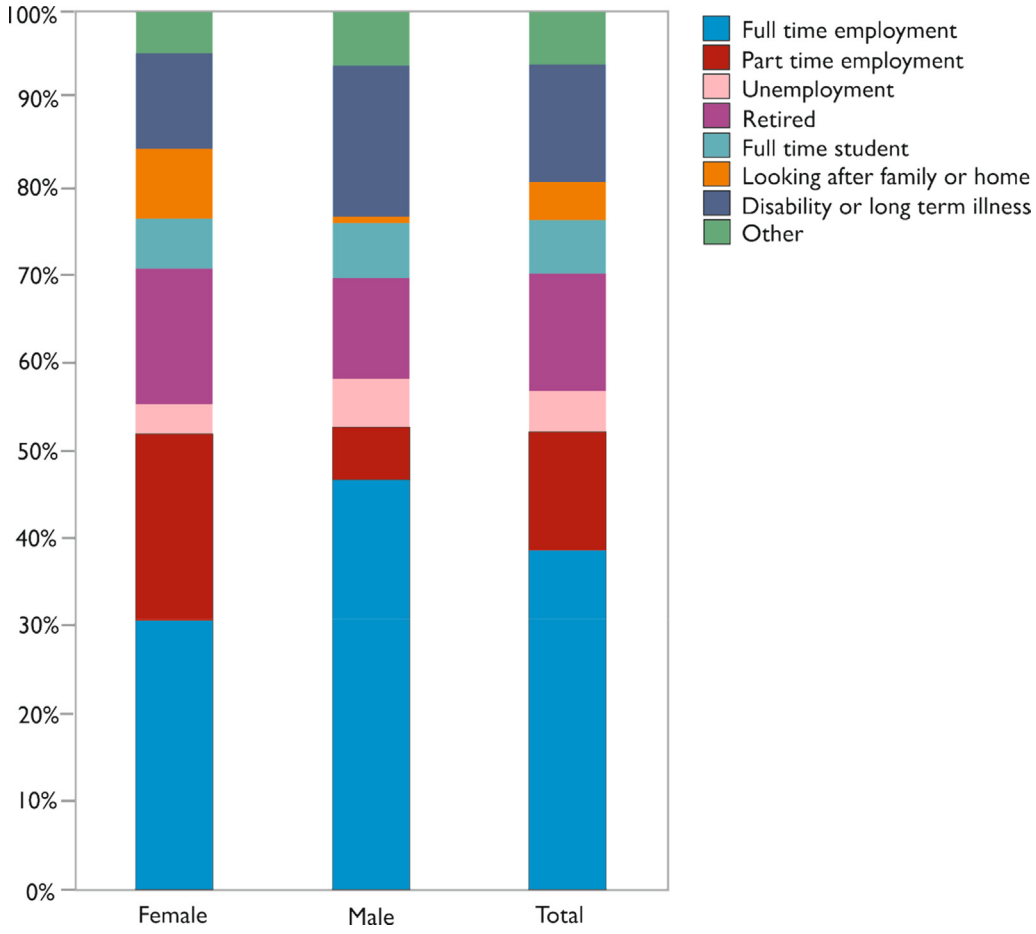

Fig. 3. Economic (in)activity of persons aged 16–74 years broken down by sex (ONS, 2011a).

age, disability and illness, demographics that tend to be recognised as vulnerable to the negative physiological impacts of energy poverty including being without sufficient warmth or coolth (Chard and Walker, 2016; Snell et al., 2015). Women also tend to be more sensitive to ambient temperature (Clancy et al., 2017). Concerning older age, although Wilkinson et al. (2004) recognise that older women are slightly less exposed to winter mortality, they do not consider their over-representation in older age groups, with almost a third more women aged over 75 years in England (ONS, 2011a). Despite a higher life expectancy, women are more likely to suffer from ill health during these years (Vlassoff, 2007).

Physiological vulnerability is particularly acute when combined with a lack of social protection in older age (Section 6.4). Concerning disability and illness, increased need for other energy services related to specific health conditions is likely to enhance energy vulnerability. People with a disability or illness are also less likely to be engaged in full-time employment (Snell et al., 2015) and thus the interconnections between disability and gender compound wider processes of exclusion from the labour market (Section 6.2). Additionally, Stafford et al. (2005) recognises that gender roles mean women are often more exposed to their immediate, local environment. Those carrying out caring or domestic roles are likely to spend more time at home increasing exposure to a lack of heating and associated health impacts.

In addition to physiological health, energy poverty impacts upon mental health owing to poor living conditions, energy-related debts, reduced privacy and pressure to cope with negative outcomes (Snell et al., 2015). Gender-sensitive indicators allow for limited exploration of these aspects of vulnerability, not least because mental health has rarely translated into sub-regional quantitative datasets and is under-researched in relation to energy poverty (Liddell and Morris, 2010). However, evidence of the final theme of coping suggests that energy poverty is likely to disproportionately impact upon the mental health of women. For example, qualitative research with women living in poverty who have responsibility for dependents highlights feelings of chronical exhaustion, tiredness and stress (Breitkreuz et al., 2010).

6.4. *Lack of social protection during life course*

A substantial body of research highlights vulnerability to energy poverty amongst older people, especially those on a low income, state pension or living alone (Chard and Walker, 2016; Wilkinson et al., 2004). Fraser (1994) discusses how social protection, including financial support during older age, tends to be linked to employment. Thus, the structural inequalities in the labour market and welfare provision that mean that women earn less, own less and assume greater responsibility for unpaid work translate into gender inequality during later life. Due to the gendered division of labour, women are less likely than men to accrue a substantial pension. A Fair Deal for Women (2016) highlight how a woman's personal pension is 62% of the average man, whilst of £82 billion in tax increases and cuts to social security in 2010, 81% came from women. During older age, women are more likely to be exposed to energy poverty due to the interaction between reduced financial capacity and increased physiological vulnerability. This vulnerability is made more acute by the increased likelihood of women of a pensionable age living alone, a phenomenon that can make heating the home and affording energy bills problematic without support financially from another person, particularly under-occupied or energy inefficient properties (Healy and Clinch, 2004).

In England, indicators associated with a lack of protection throughout the life course concentrate in relatively remote rural areas

and coastal communities that have a higher percentage of people in older age groups. At this point, it is worth reflecting upon the temporalities of gendered energy poverty. Gendered vulnerability associated with unpaid caring roles and exclusion from a productive economy, typically associated with working age adults, can translate into vulnerabilities in the future with regards to accruing a substantial pension.

6.5. Coping and helping others to cope

Finally, as poverty debates highlight 'income shocks' (Thorbecke, 2007), energy poverty research recognises the incidence of 'cold weather shocks' in low income households (Bhattacharya et al., 2003), both instances in which consumption cannot be smoothed and therefore coping mechanisms must be employed. Examples of such coping mechanisms include going without energy services or managing the subsequent debt from necessarily overspending (Middlemiss and Gillard, 2015). Similarly, a more constant and high need for energy services due to disability, illness or age also impacts upon ability to cope (Snell et al., 2015).

In wider literatures concerned with poverty, responsibility for a household coping is more likely to fall to women. Bondi and Christie (2000) recognise how under conditions of material stress (such as energy poverty) long-standing gender divisions tend to be intensified. For example, participants in a project about empowering women experiencing poverty described 'sacrificing their own food, clothing, heat and other basic needs in order to put their families first' (Joseph Rowntree Foundation, 2002: 9). This relatively private aspect of vulnerability is not well represented by sub-regional, quantitative datasets, however, coping is disproportionately associated with several gender-sensitive indicators, namely lone parents, unpaid carers and those looking after the family or home (Breitkreuz et al., 2010). In addition, there are gendered aspects to these vulnerabilities that can make coping harder, for example, a greater proportion of women have limited proficiency in England, a factor that may affect coping mechanisms including the ability to switch to cheaper tariffs (Lorenc et al., 2013). Conversely, women are often less likely to receive support from others with coping, for example, in dealing with a health condition (Vlassoff, 2007).

6.6. Spatial intersections of gendered vulnerability to energy poverty

In recognising the limitations of gender as a single analytical category (McCall, 2005), feminist scholars have drawn attention to its intersection with other forms of social difference reflecting a concern with *which* women are experiencing vulnerability to energy poverty (Benería and Roldan, 1987; Crenshaw, 1991). Interconnections between gender and other forms of social differentiation are touched upon in the five dimensions of gendered energy vulnerability, in particular recognising intersection with age, disability and ethnicity. To further this, Fig. 4 explores the *spatial* intersection of gendered aspects of vulnerabilities mapping the high Clusters according to each indicator. Analysis of these spatial intersections is a relatively crude method of analysis (Section 7), but reveals an uneven patchwork of gendered vulnerability across England in relation to securing adequate energy services in the home.

The greatest concentrations of HH Clusters are found in large urban conurbations, primarily Birmingham, Manchester, Leeds, Liverpool, Sheffield and Newcastle. Here, gendered vulnerability associated with unpaid caring and domestic roles combine with the indicators representative of low proficiency in English and full-time students, typically more transient groups likely excluded from the labour market (Hernández et al., 2016; Reames, 2016; Petrova, 2017; Butler and Sherriff, 2017). The exception is the capital city of London which has a relatively low level of disability and illness, partly attributed to the younger age population as a result of employment opportunities (ONS, 2011a). However, caring and domestic roles carried out by lone parents are also spatially concentrated in London. In contrast, the gendered vulnerability associated with older age groups, especially those living alone, that include a susceptibility to negative physiological impacts and a lack of a substantial pension contribution, spatially concentrate in relatively isolated rural and coastal areas (Chard and Walker, 2016). As highlighted in Fig. 4, these areas tend to be associated with a lower number of high Clusters (perhaps only two or three), as they have fewer associations with other indicators, namely with part-time employment. However, the spatial distribution of gendered vulnerability related to disability and illness spans these distributions, concentrating in urban conurbations outside London with a high percentage of unpaid care, but also spatially intersecting with indicators associated with older age, a group who are more likely to suffer from a disability or illness (Snell et al., 2015), particularly in deprived coastal communities (Fernández-Bilbao, 2011). The relationship between gender and energy poverty therefore has a diverse spatiality that is unlikely to be accounted for by traditional poverty and energy poverty metrics that are often predicated upon an urban versus rural deprivation binary (Robinson et al., 2017, 2019).

7. Limitations of gender-sensitive indicators of vulnerability to energy poverty

There are several aspects of the conceptual and methodological approach of deriving gender-sensitive indicators of vulnerability to energy poverty that necessitate reflection. Firstly, due to restrictions regarding neighbourhood-scale datasets, comprised of individuals rather than households, the analysis is what McCall (2005) terms inter-categorical, *necessarily* adopting existing analytical categories (including women and men) to highlight processes of marginalisation. Despite having a useful role in making visible the positions and outlooks of women (DeVault, 1996) such categorisations obscure a variety of non-binary gender identities (Butler, 1990; Valentine, 2007). An inability to simultaneously disaggregate individual-scale datasets along various axes of social difference also necessitates what is a relatively crude, additive method to examine geographical intersections between gendered vulnerabilities.

Secondly, the focus upon the individual as the unit of analysis within neighbourhoods mean that several aspects of vulnerability to energy poverty are neglected. Whilst it is possible to draw conclusions regarding gendered energy vulnerability associated with health and economic activity, this is more complex in relation to energy-related infrastructures that play a vital role in enhancing vulnerability to energy poverty. Data concerning energy consumption, fuel types, energy-related infrastructures and the built environment is only available at the scale of the household, a unit that makes research 'gender-blind' by assuming an equitable distribution of resources between household members (Millar and Glendinning, 1989). This represents a substantial barrier to considering the gender relations between household members and these infrastructures using existing datasets.

Finally, several aspects of gender inequality are relatively private and not amenable to quantification, for example, energy-related household practices (Middlemiss and Gillard, 2015), the emotional labour of energy poverty (Petrova and Simcock, Under review) or the domestic, tech-work of the smart home (Strengers and Nicholls, 2017). Such limitations mean that neighbourhood-scale, quantitative assessments underestimate and simplify the multi-faceted inequalities associated with gender and should therefore be underpinned by in-depth qualitative research (Chant, 2006).

8. Conclusion

Substantial inequalities exist in domestic energy provision, sustained and produced by a neo-liberal, austerity-oriented economic system. One way in which these inequalities are shaped is through socially and spatially contingent gender relations (McDowell, 1999,

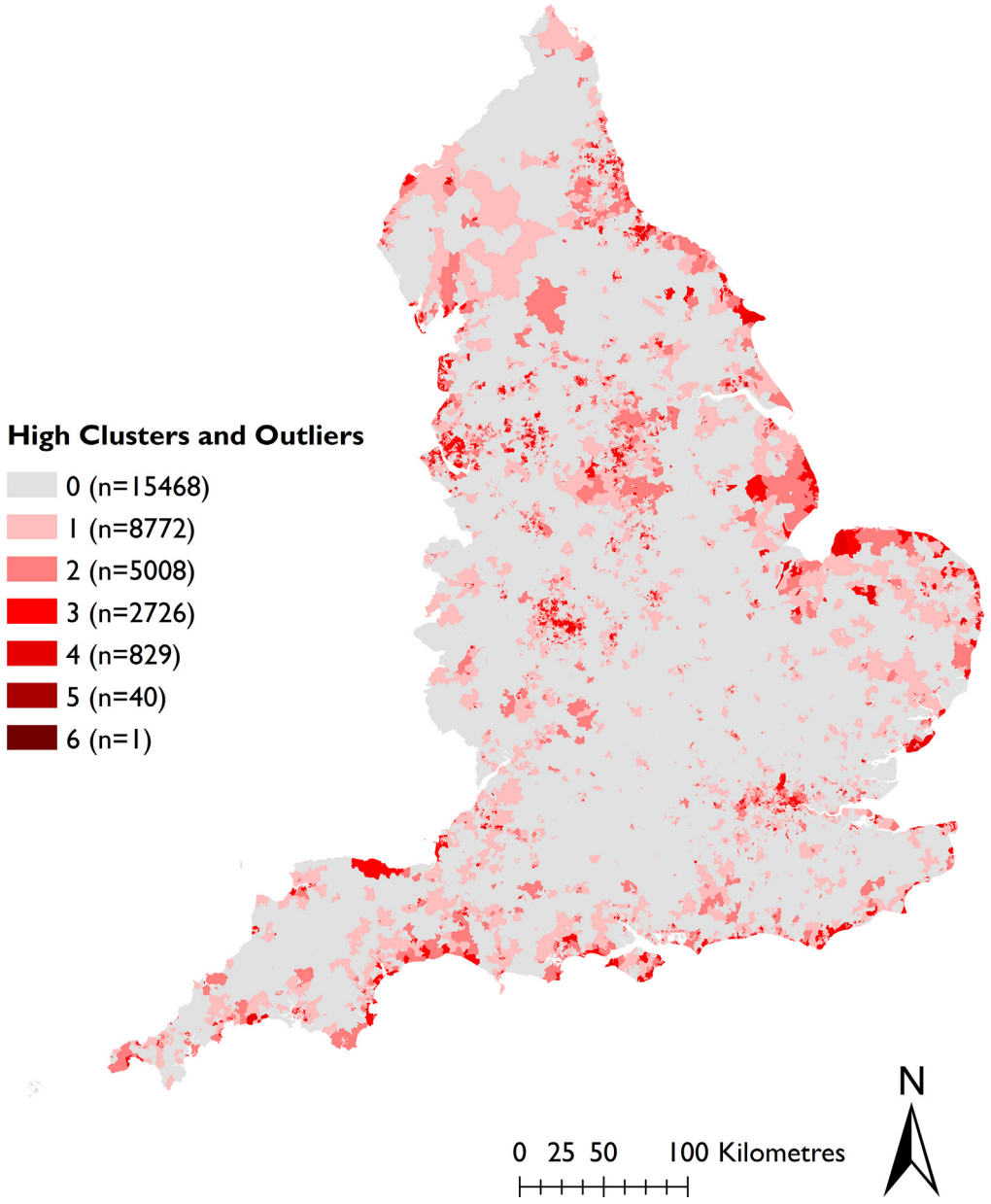

Fig. 4. Spatial intersection of HH Clusters according to gender-sensitive vulnerability indicators. A value of 0 indicates that the LSOA is not part of a High Cluster or Outlier for any gender-sensitive indicator. A value of between 1 and 6 indicates that the LSOA is part of a High Cluster or Outlier for atleast one indicator Boundary data available from: ONS 2011b.

Massey, 1994), an area underexplored with regards to energy poverty. The central aim of the paper was to uncover the spatialities of gender and energy poverty for a case study of England. In fulfilling this aim, I respond to a need for analyses that reach beyond a "feminization of energy deprivation" (Petrova and Simcock, Under review: 1) or the disempowering and victimising gender discourses that dominate existing research (Listo, 2018). Secondly, the analysis fulfils a need for research that scrutinises the geographies of gendered energy vulnerability (Petrova and Simcock, Under review). Thirdly, it contributes towards a better understanding of the relationship between gender and energy poverty, and subsequently gender-sensitive measurement approaches, in the Global North a geographical context that has received comparatively less attention (Clancy et al., 2017).

In fulfilling this aim, the paper sets out how an energy vulnerability framing can shed light on the relationship between gender and energy poverty. It demonstrates how a vulnerability framing, increasingly used to understand a household's exposure to energy poverty (Bouzarovski and Petrova, 2015; Middlemiss and Gillard, 2015), offers a means of challenging the assumption that gender inequality is entirely synonymous with energy poverty. The framing also provides a powerful means of recognising socio-spatial differentiations in the degree of susceptibility to energy poverty. However, in accounting for gender there is a need to move beyond a focus upon the household to recognise the vulnerability of individuals.

Through the derivation of gender-sensitive vulnerability indicators, five dimensions that enhance the likelihood of women and other marginalised groups experiencing energy poverty are evidenced: exclusion from a productive economy; unpaid caring or domestic roles; susceptibility to negative physiological and mental health impacts; a lack of social protection throughout a life course; and coping and helping others to cope. Many of the gendered dimensions of energy vulnerability identified have a substantial overlap with experience of wider forms of income or material poverty, an overlap that Middlemiss (2017) considers to be downplayed in existing efforts to research and tackle

energy poverty. The analysis here deliberately engages with literatures concerned with poverty, partly because of the absence of exploration of gender in energy poverty debates to date, but primarily owing to the integral role of labour markets and state support during older age in experience of energy poverty. Despite these similarities, and the recognition of opportunities for cross-fertilisation between the two research agendas, the vulnerability dimensions identified are also inherently bound up with the energy-related activities and infrastructures that distinguish energy poverty from other forms of deprivation (Boardman, 1991).

The analysis recognises how, in conjunction with other forms of social difference, gender inequality shapes vulnerability to energy poverty. The intersection of gender with age, able-ness and ethnicity gives rise to diverse and contradictory geographies of gendered vulnerability to energy poverty. However, the conceptual and methodological limitations of deriving gender-sensitive indicators mean that neighbourhood-scale quantitative assessments inevitably underestimate, or misrepresent gendered energy vulnerabilities. Whilst it is possible to draw initial conclusions about the spatialities of gendered energy vulnerability associated with health and economic activity, this is more complex concerning gendered aspects of energy vulnerability related to infrastructure that tend to be measured at the scale of the household, or those aspects of vulnerability that are relatively private or personal. Despite these caveats, the findings emphasise that energy in a Northern context is not "gender-neutral" as is often assumed (Clancy and Roehr, 2003: 44), instead highlighting a diverse array of gendered, socio-spatial vulnerabilities that exist in relation to energy poverty. It is therefore hoped that the findings will stimulate further conversations about the relationship between gender and energy poverty.

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